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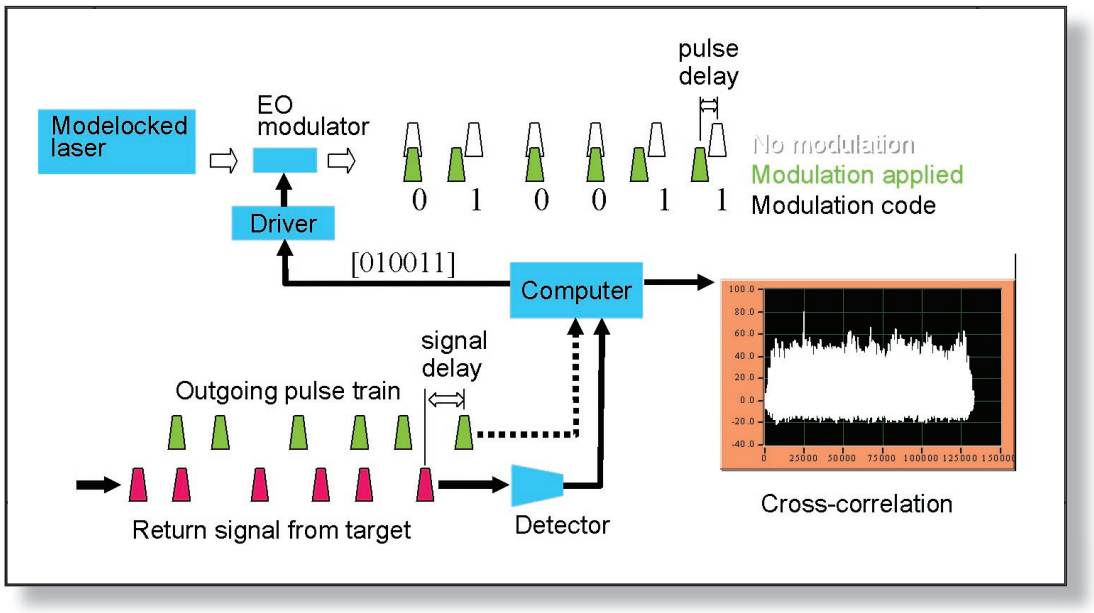
Success Story

LASER SENSING CAPABILITY ENHANCES TARGET RANGING AND IDENTIFICATION



A new technique, based upon pulse modulation of a mode-locked laser source, enhances target identification and ranging capability with a smaller laser that will support transition of laser sensing capability to tactical aircraft and unmanned air vehicles. This technique easily provides a resolution of better than 25 cm and eliminates the need for high-energy pulses that are difficult to generate and can damage optics.

Air Force Research Laboratory
Wright-Patterson AFB OH

Accomplishment

The Sensors Directorate's Electro-Optical Countermeasures Technology Branch at Wright-Patterson Air Force Base, Ohio, recently demonstrated a novel technique for target ranging and identification based upon pulse modulation of a mode-locked laser source. The mode-locked laser itself is a compact, rugged, room-temperature source well suited to multifunctional use.

Directorate engineers used a passively modelocked, 0.5-Watt (W) neodymium laser with electro-optic modulation and a 1-GHz-bandwidth detector to determine range to target and target depth information in the laboratory with a resolution of better than 25 cm. The engineers simultaneously ranged multiple targets with the same 25-cm resolution.

The 40-ps laser pulsewidth translates into high peak power at the target, and the MHz-level repetition rate permits signal averaging over many pulse trains, yielding accurate results at signal-to-noise ratios below 0.1. Modeling suggests laser average power requirements remain a challenge for airborne laser radar applications, with upwards of 100 W likely needed for extension of this technique to ranges over 10 km. Directorate engineers expect ongoing advances in both laser sources and detectors to boost overall system throughput to allow realization of its potential.

Background

The mode-locked target identification (ID) approach exploits the technique of pulse position modulation, long used in radio frequency applications, and more recently applied to optical communications. The mode-locked target ID approach directs the mode-locked laser output at the target in pulse trains of fixed length, modulated with a known pseudo-random pattern where it delays some pulses by a small fraction of the pulse period and transmits others without delay.

In the absence of modulation, each pulse looks like the next, but the known modulation pattern enables the detection system to recognize a specific pulse train upon its return. The mode-locked target ID approach determines range to target by measuring the pulse train's round trip time and obtains the target depth information from the degree to which the pulses are smeared out in time.

The mode-locked target ID approach performs comparison of the scattered return signal with the known outgoing pattern by means of a mathematical cross-correlation, then averages many pulse trains to pull the signal out of the noise. The approach can use multiple range measurements to obtain target velocity information.

Sensors
Emerging Technologies

Additional information

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